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Governing the commons in Mexico's Mixteca Alta: Linking Ostrom's design principles and *comunalidad*

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ABSTRACT

Elinor Ostrom demonstrated the inadequacy of the "tragedy of the commons" thesis, according to which natural resources are depleted in common-property systems because individuals have few incentives to limit their consumption, leading to the idea that privatization or government intervention are needed. Ostrom showed that the tragedy of the commons can be avoided by the users of a common-pool resource themselves through self-organized and self-governed arrangements. She also proposed a series of "design principles" that would favor a successful governance of common-pool resources. In this paper, we use Ostrom's design principles as a framework to study the governance of wooded areas and grazing lands in 10 communities of Mexico's Mixteca Alta region. Based on interviews with local authorities, we corroborate that Ostrom's design principles are key factors that help explain a successful governance of common-pool resources. Furthermore, we argue that this success is also rooted in the characteristics of local governance systems, which are based on indigenous uses and customs and an ethos of communality (*comunalidad*), and have been formalized by the Mexican State. By showing the links between Ostrom's design principles and *comunalidad*, we highlight the importance of taking into consideration the local context and social capital to explain the successful governance of common-pool resources.

1. Introduction

Governance has been described as "the conditions for ordered rule and collective action or [the] institutions of social coordination", or, in other words, "the structures and processes by which people in societies make decisions and share power" (Folke et al., 2005: 444). For its part, a common-pool resource (CPR), or simply a "commons", can be understood as a "valued natural or human-made resource or facility that is available to more than one person and subject to degradation as a result of overuse" and for which "exclusion from the resource is costly and one person's use subtracts from what is available to others" (Dietz et al., 2002: 18). Forests, grazing lands, river and groundwater basins, and fisheries are typical examples of CPRs. The governance of the commons thus refers to the conditions for ordered rule and collective action regarding natural or human-made resources that are shared by a group of people and are subject to degradation as a result of overuse.

A recurring theme in the literature is the factors that favor a successful, and thus a sustainable, governance of CPRs. After reviewing decades of studies on shared-resource management, Elinor Ostrom, in her seminal work *Governing the Commons: The Evolution of Institutions for Collective Action* (Ostrom, 1990), and more recently in other key works such as *Understanding Institutional Diversity* (Ostrom, 2005), demonstrated the inadequacy of the "tragedy of the commons" thesis, first developed by Garret Hardin (1968). This thesis contends that CPRs are depleted because individual users tend to act in their own self-interest and overexploit those resources, and thus that privatization or government intervention are needed to restrict usage and avoid this depletion. Ostrom (1990, 2005) showed that the tragedy of the commons can be avoided by the users themselves through self-organized and self-governed arrangements without privatization or top-down government intervention. In addition, she proposed a series of factors, which she labeled "design principles", that would favor a successful local governance of CPRs (Ostrom, 1990: 90–102; Ostrom, 2005: 258–270). Those eight design principles are the following:

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1) Clearly defined boundaries. Authorized users of a CPR should be clearly defined, as should the boundaries of the CPR itself. Without those boundaries, it is not clear what is being managed and for whom, which discourages coordinated efforts to manage and regulate the resource. CPRs should not be managed as open-access resources available to all.
2) Congruence between the rules and local conditions. The rules governing the use of a CPR should be well-tailored to local needs and conditions (ecological, social, and cultural conditions), reflecting the specific attributes of the particular resource and the context. Those rules include appropriation rules (rules limiting appropriation of the resource by the users) and provision rules, that is, rules requiring users to actively help enhance and maintain the CPR through their labor and resources.
3) Collective-choice arrangements. Most or all of the users of a CPR should be able to participate in modifying the appropriation and provision rules, which helps provide legitimacy to those rules, in turn promoting compliance.
4) Monitoring. Rules should be enforced by effective monitoring activities, which are key to promote compliance. The monitors who audit the conditions of a CPR and the behavior of its users should be accountable to those users or they should be the users themselves.
5) Graduated sanctions. Users of a CPR who violate rules should be assessed graduated sanctions depending on the seriousness and the context of the offense. Small penalties are often sufficient to ensure compliance, as violators' reputations are also affected. On the contrary, harsh penalties may produce resentment and unwillingness to conform to the rules in the future, and hence should be used only in grave circumstances.
6) Conflict-resolution mechanisms. Users of a CPR and their officials should have rapid and easy access to low-cost local arenas to resolve conflicts among users or between users and officials.
7) Minimal recognition of rights to organize. The rights of users of a CPR to devise their own institutions should not be challenged by external governmental authorities.
8) Nesting principle. In the case of large CPRs, whose use extends over various communities (for example, large river or groundwater basins), rules should be organized and enforced through multiple layers of nested initiatives and governance bodies, resembling a federated system. That is, local forms of organization should not be absorbed into a larger organization or sidelined, but included in a multi-level and polycentric governance system, operating from the local to the regional levels. This nesting principle is thus a way of scaling up the community-based management of CPRs much beyond the local or community level.

These design principles would be important individually, though evidently their effectiveness would be greatest when operating in conjunction. As Ostrom (2005: 267) notes regarding the first five design principles:

> When the users of a resource design their own rules (design principle 3) that are enforced by local users or accountable to them (design principle 4) using graduated sanctions (design principle 5) that clearly define who has rights to withdraw from a well-defined resource (design principle 1) and that effectively assign costs proportionate to benefits (design principle 2), collective action and monitoring problems tend to be solved in a reinforcing manner.

This paper analyzes the governance of CPRs in 10 communities that are part of the Mixteca Alta UNESCO Global Geopark, a 415-km^2 area made up of nine municipalities located in the southern Mexican state of Oaxaca. This geopark was the focus of two previous articles (Lorenzen et al., 2020, 2021) in which we show, based on official land/use-cover maps and qualitative fieldwork, that the area has undergone an expansion of its wooded areas after a long period of deforestation, a process known as a forest transition (Mather, 1992). This forest transition in the geopark, which initiated in the 1990s, is linked to depopulation, deagrarianization, agricultural intensification, the decline or change in livestock, and the decline in the use of farmland, grazing lands, and local natural resources (particularly wood). In addition, we found that changes in the local governance of CPRs, leading to reforestations and stricter rules regarding logging and grazing on common-use lands, are also key factors that help explain the forest transition in the geopark (Lorenzen et al., 2020, 2021; also, see Hernández-Aguilar et al., 2021).

This paper contributes to those previous findings by analyzing the relevance of Ostrom's design principles to explain the successful governance of wooded areas and grazing lands in our study area. In addition, our paper goes further by studying the links between Ostrom's design principles and the characteristics of local governance systems, which are based on indigenous uses and customs and an ethos of communality (*comunalidad*), while also being formalized by the Mexican State. We should note that we exclude Ostrom's eighth design principle from our analysis, since there is no nested governance system in our study area scaling up the governance of wooded areas and grazing lands to a larger, regional level.[1] In this respect, it is important to note that UNESCO global geoparks do not impose any restrictions on economic activities or on land and natural resource use in the communities belonging to a geopark, which makes them different than UNESCO biosphere reserves and other protected areas (UNESCO, n.d.).[2] Nevertheless, the Mixteca Alta UNESCO Global Geopark may, in the future, provide a basis for a nested governance system of CPRs in the geopark's communities.

2. Local governance systems in rural Oaxaca

Before studying the relevance of Ostrom's design principles in our study area, it is important to describe the particular characteristics of local governance systems in rural Oaxaca, many of which are based on indigenous uses and customs (*usos y costumbres*) and are themselves embedded in the ethos of *comunalidad*. Indigenous uses and customs are a form of customary governance constituted by "a set of written and unwritten rules and general principles used by indigenous communities […] to organize their members and collective lives" (Hernández-Díaz and Robson, 2019: 30). In Oaxaca, important aspects of indigenous uses and customs were formally recognized by state law in the 1990s, giving indigenous communities a large degree of autonomy in the way they govern themselves, including how they elect their municipal authorities, how local decision-making is carried out, how they organize and fulfill municipal duties, and how they administer justice and resolve internal conflicts and conflicts with other indigenous communities (Gobierno del Estado de Oaxaca, 1998). In addition, state law acknowledges that indigenous communities have the right to monitor and establish rules and sanctions to protect the natural resources within their territories, based on their uses and customs, and also indicates that the state government should recognize, validate, and support those initiatives (Gobierno del Estado de Oaxaca, 1998).

Indigenous customary governance in Oaxaca, as well as in Mexico as a whole, is embodied in two main institutions that deal with separate issues: (1) the municipal government, whose responsibilities include public security, running the public water and sewage system, garbage collection and disposal, street lighting, and administering the local cemeteries and markets, to name the most important, and (2) the

[1] Nested governance systems of CPRs are, however, common in the Sierra Norte region of Oaxaca, which is to the east of the Mixteca Alta region. See, for example, Chapela (2007), Gasca Gasca Zamora, 2014, and Merino (2008).

[2] Of course, we do not wish to imply that protected areas such as UNESCO biosphere reserves and Mexican natural protected areas necessarily provide a basis for a nested governance system. On the contrary, these forms of protection have at times been criticized for being too centralized and top-down focused (e.g. Merino, 2008).

agrarian community—and in some cases the *ejido*—that is responsible for managing and regulating land and CPRs (including wooded areas and grazing lands).

Municipalities are the smallest administrative division of the Mexican State. There were 2463 municipalities in Mexico in 2018, of which 424 were governed according to indigenous uses and customs, also called indigenous normative systems (*sistemas normativos indígenas*) (INEGI, 2019). Of those 424 municipalities, a full 417 were located in Oaxaca, representing more than 73% of the state's 570 municipalities (IEEPCO, 2020). All nine municipalities of the Mixteca Alta UNESCO Global Geopark are governed according to indigenous uses and customs. As mentioned above, in Oaxaca these indigenous normative systems at the municipal level were formalized by state law in the 1990s.

Municipal governments in Mexico are headed by a municipal president and a council, elected every three years. However, in municipalities based on indigenous normative systems there is also a higher authority, which is the community assembly, made up of all adults who reside in the municipality. This assembly makes the most important decisions and may remove the municipal president and council. Another distinguishing feature of indigenous normative systems is that there are no political parties at the local level and that positions in the municipal government are often not remunerated, as they are considered a public duty—we further explain this below, when describing *comunalidad*.

However, the main focus of this paper is on a different institution, namely, the agrarian community, which, as mentioned before, is responsible for managing and regulating land and CPRs (including wooded areas and grazing lands) in indigenous communities in Mexico. Nevertheless, as we note below, some indigenous communities in Mexico are not comprised within agrarian communities but *ejidos* (although this is not the case in our study area). The responsibilities of municipal governments, on the one hand, and agrarian communities and *ejidos*, on the other, do not generally overlap, but there are some exceptions. For instance, as we note in Subsection 5.4, municipal authorities in our study area tend to assist the authorities of the agrarian communities in monitoring CPRs, at the request of the latter.

Agrarian communities, together with *ejidos*, are a common-property system that was born out of the 1910–1920 Mexican Revolution. There are currently 32,213 agrarian communities and *ejidos* in Mexico, greatly surpassing the number of municipalities, meaning that there are generally two or more agrarian communities and/or *ejidos* within each municipality (RAN, 2020). *Ejidos* form the bulk of this common-property system, as there are 29,802 in Mexico (854 in Oaxaca). As for agrarian communities, there are 2411 nationwide, with Oaxaca being by far the state with the highest number, namely, 748 (31% of the total). Together, agrarian communities and *ejidos* cover just over half (50.9%) of nation's land surface (the rest is made up of private property and public lands), while in Oaxaca they cover 81.1% of the state's land surface, with agrarian communities alone covering 63.4% (INEGI, 2018; RAN, 2020). In other words, the majority of Oaxaca's surface and the natural resources found there, including forests, shrublands and grasslands, are part of and managed by agrarian communities—in fact, Merino (2008) estimates that 80% of Oaxaca's forests are located in agrarian communities. This paper centers its attention on 10 of the 16 agrarian communities that comprise the Mixteca Alta UNESCO Global Geopark.

Agrarian communities and *ejidos* are composed of a group of people with land rights—*comuneros* in the case of agrarian communities and *ejidatarios* in the case of *ejidos*—and a territory, made up of individual agricultural plots and residential plots, as well as common-use lands (*tierras de uso común*). These common-use lands are mainly wooded areas and grazing lands and are the common property of the *comuneros* or *ejidatarios*. The common-use lands cannot be sold and cannot be lost: they are considered by law to be inalienable, imprescriptible, and not subject to seizure, except when they are expropriated by presidential decree for the public good (generally to build public infrastructure). However, the *comuneros* or *ejidatarios* are allowed to transfer the rights of the common-use lands to a company or an organization in which the agrarian community, the *ejido* or the *comuneros* or *ejidatarios* are associates, a process that has not occurred in our study area (Cámara de Diputados, 2018).

The highest authority in agrarian communities and *ejidos* is the assembly of *comuneros* or of *ejidatarios*, respectively, which elects a *comisariado* (*de bienes comunales* or *ejidal*, respectively) and an oversight council (*consejo de vigilancia*). The *comisariado* is tasked with representing and managing the agrarian community or *ejido*, as well as executing the decisions made by the assembly, while the oversight council monitors the *comisariado*'s use of funds and its compliance with agrarian law and local rules (Cámara de Diputados, 2018). The *comisariado* and the oversight council are made up of three members each, with their respective substitutes (*suplentes*), who are elected for three-year periods.

Comuneros and *ejidatarios* are individuals with land rights in an agrarian community or *ejido*, who obtained their status from the original presidential decree establishing the agrarian community or *ejido*, or by inheriting land rights from another *comunero* or *ejidatario,* and/or by being recognized as *comuneros* or *ejidatarios* by the respective assembly. Another legal figure in agrarian communities and *ejidos* is the *avecindado*. According to Mexico's Agrarian Law, *avecindados* are adults who have lived more than one year in the agrarian community or *ejido* and who have been recognized as *avecindados* by the assembly of *comuneros* or *ejidatarios* or by an agrarian tribunal (Cámara de Diputados, 2018). *Avecindados* can be provided rights over individual plots (residential or agricultural), but their access to common-use lands and the CPRs found there (such as forests and grazing lands) differs from agrarian community to agrarian community (or from *ejido* to *ejido*). Being recognized as an *avecindado* is often considered a first step before becoming a *comunero* or *ejidatario*. In some agrarian communities and *ejidos*, *avecindados* participate in the assemblies but without the right to vote, while in others they are not allowed to participate in the assemblies at all.

Mexican agrarian communities and *ejidos* are very similar common-property systems, but their origin is quite different. Agrarian communities are lands returned to indigenous communities or recognized as belonging to those communities by presidential decree during and after the Mexican Revolution.[3] Their origin can be found in the colonial period, when indigenous communities were given royal documents establishing their territories, which included residential, agricultural, and common-use lands. During and after the Revolution, these territories were legally recognized by the Mexican State, based on those colonial documents, and were named agrarian communities. For their part, *ejidos* are typically lands that were confiscated from large landowners (haciendas) by presidential decree during and after the Revolution and given to organized groups of peasants. However, many indigenous communities in Mexico became *ejidos* and not agrarian communities (some even have both forms of property), especially because not all of them had the necessary colonial documents proving their origin (Morett-Sánchez and Cosío-Ruiz, 2017).

One of the key social demands during the Mexican Revolution was an agrarian reform to dismantle the enormous concentration of land in few hands.[4] This led to the creation of agrarian communities and *ejidos*. However, agrarian communities and *ejidos* were not automatically formed during or soon after the Revolution. For the most part, indigenous and peasant communities had to struggle many years and even decades to pressure the government to grant them their agrarian

[3] The lands were returned to indigenous communities when they had been lost to large landholders, generally haciendas, or they were recognized as belonging to those communities when the communities already had control over them (Assies, 2008).

[4] It is estimated that, just before the Mexican Revolution, 87% of the land occupied by rural holdings was in the hands of 0.2% of landowners (Assies, 2008: 39).

communities and their *ejidos*.[5] Even though the agrarian reform process officially ended in 1992, when changes to the Mexican Constitution were enacted, some agrarian struggles continue to this day regarding the definition of borders—in 2020 there were 352 agrarian communities and *ejidos* with agrarian conflicts in Mexico (RAN, 2021).

The formalization of agrarian communities and *ejidos* implied the formation of new local governance institutions (assemblies, *comisariados*, and oversight councils), following the model of internal organization imposed by the Mexican State described above. This was not always an easy process because it meant changing local governance arrangements, at times stripping power from local *caciques* (chiefs or bosses). In this sense, the formalization of indigenous commons must be understood not only as the legal recognition of resources and their borders claimed by indigenous groups, but also as the formalization of local governance structures regarding those resources (Monterroso et al., 2019)—on the issue of the formalization of indigenous commons in Latin America and its various challenges, see Larson et al. (2015), and Monterroso et al. (2019).[6]

Despite having a general model of internal organization that was imposed by the Mexican State, it is incorrect to assume that agrarian communities (and *ejidos* with indigenous communities) are institutions devoid of indigenous uses and customs. On the contrary, indigenous communities had the capacity to culturally appropriate these institutions, to make them their own (Merino, 2008). Indeed, three aspects of the indigenous ethos, which we further explain below, coincide with characteristics of agrarian communities and *ejidos*, providing them with legitimacy: the importance of a communal territory, expressed especially in the fact that common-use lands are the common property of *comuneros* and *ejidatarios*; the importance of the assembly as the main decision-making body, materialized in the assembly of *comuneros* or *ejidatarios*; and the importance of communal work, put in practice, for instance, in a form of community work called *tequio*, which exists in many agrarian communities and *ejidos* with indigenous communities, especially in southern Mexico. In addition, positions of authority in agrarian communities and *ejidos* (in the *comisariado* and the oversight council) are generally not remunerated since they are considered a public duty, similar to positions of authority in municipalities based on indigenous uses and customs. Lastly, agrarian communities and *ejidos* have the autonomy to create their own internal rules based on their uses and customs, as long as those rules do not contradict Mexican Agrarian Law. Those internal rules—called communal statutes in the case of agrarian communities and internal regulations in the case of *ejidos*—are discussed and voted in the assembly of *comuneros* or *ejidatarios* and are formalized by registering them at Mexico's National Agrarian Registry (Registro Agrario National, RAN). These communal statutes and internal regulations address issues such as the social and economic organization of the agrarian community or *ejido*, the rules to accept new *comuneros* or *ejidatarios*, and the rules relating to the use of common-use lands and CPRs (Cámara de Diputados, 2018).

However, this focus on communal aspects should not hide the fact that there are important power inequalities within agrarian communities and *ejidos*. These power inequalities may be linked to the existence of various factions with diverging interests within the communities, but are more generally expressed simply in terms of gender and age (Gasca Zamora, 2014). It is important to note that the people given land rights in agrarian communities and *ejidos* (that is, *comuneros* and *ejidatarios*) during and after the Revolution were generally men. Women were, and in large part continue to be, excluded from being *comuneras* and *ejidatarias*. Also, those inheriting land rights are often the male sons of *comuneros* and *ejidatarios*. These factors explain why, in 2021, 73.8% of *comuneros* and *ejidatarios* in Mexico were men, with a similar percentage (71.8%) in Oaxaca (RAN, 2022). The predominance of men is even higher in the *comisariados* and oversight councils of agrarian communities and *ejidos*, where, at the national level, 78.8% of representatives were men in 2021, with an even higher percentage (81.2%) in Oaxaca (RAN, 2022). Youths have also been excluded to a large degree from being *comuneros* and *ejidatarios* for different reasons, including their lack of interest to continue farming, rural out-migration, the lack of sufficient land to distribute, and the fact that many of them do not get access to land until their parents pass away. As a result, the average age of *comuneros* and *ejidatarios* in Mexico was 59.8 in 2019. In fact, a full 70.5% were more than 50 years old and 39% were more than 65 (Procuraduría Agraria, 2020). However, these power inequalities are not absolute, as *avecindados* can often voice their opinion in the assemblies of agrarian communities and *ejidos*, as noted above.

A crucial characteristic of indigenous uses and customs in Oaxaca is their embeddedness in an ethos of communality (*comunalidad*), which highlights the importance of communal life (Hernández-Díaz and Robson, 2019: 31; Martínez Luna, 2010; Robson et al., 2018). This ethos of communality forms the basis of the organization and way of life of indigenous communities in Mesoamerica, but more markedly in Oaxaca, as well as the basis of indigenous resistance starting from the colonial period to current struggles for autonomy and self-determination (Fuente Carrasco, 2013; Maldonado Alvarado, 2002, 2015; Martínez Luna, 2010, 2017; Nava Morales, 2018). The importance of *comunalidad* and the resilience of traditional and communal forms of social organization in Oaxaca are factors that help explain why the governance of CPRs is particularly strong in this state (Chapela, 2007; Gasca Zamora, 2014; Merino, 2008).

Comunalidad is viewed in opposition to individualism and is expressed in four aspects of communal life (Díaz Gómez, 2001, Díaz Gómez, 2004; Fuente Carrasco, 2013; García Sánchez, 2018; Gasca Zamora, 2014; Maldonado Alvarado, 2002, 2015; Martínez Luna, 2010, 2017; Merino, 2008; Nava Morales, 2018; Rendón Monzón, 2003; Robson et al., 2018):

1) A communal territory. Control over a communal territory is the basis of the existence of a community, both in material and symbolic terms, that is, the basis for the physical, social, and cultural reproduction of the community. This communal territory is seen not as a commodity or a form of property but as an indissoluble and sacred living thing that provides identity, a sense of belonging, sustenance, and rights and responsibilities to current and future generations of the community. Being the basis of the existence of the community, governance of the communal territory depends on "knowing the land" and is carried out collectively through communal power.
2) Communal power. This power is embodied in two institutions: the assembly and the *cargo* system. The assembly is the highest authority in a community, whether it be the assembly of *comuneros* for issues related to land and natural resources or the general community assembly for other issues (Fig. 1). The assembly elects those in administrative positions, carries out major decisions, and defines the rights and responsibilities of the members of the community. Carrying out decisions, preferably through consensus or near consensus, involves ample attendance and participation of the members of the community in the assemblies and ensuring that all major issues are discussed, understood, and reflected on. For its part, the *cargo* system refers to all positions in the municipal government, the *comisariado*

[5] The ideological makeup of each successive government also played a key role, which explains why a large part of the agrarian reform process took place during the progressive government of Lázaro Cárdenas (1934–1940) (Assies, 2008).

[6] For instance, Monterroso et al. (2019) note five main challenges linked to processes of formalization of indigenous commons: (1) reconciling the rights granted with existing claims over resources; (2) addressing legal overlaps in rights granted to different groups for the same area or resources; (3) enabling conditions so that recipients can actually exercise those rights and realize benefits from them; (4) building equitable governance institutions that facilitate the administration, management, and use of the commons; and (5) overcoming the assumption that management and governance institutions in indigenous commons are based solely on collective action.

Fig. 1. Communal power. Community assembly in the Mixteca Alta UNESCO Global Geopark (municipality of Sinaxtla), March, 2019 (Photo: Matthew Lorenzen).

and its oversight council, and various committees (both civic and religious)—positions that are generally not remunerated. Those elected to carry out *cargos* must implement the decisions made by the assembly and are accountable to it. *Cargos* are considered a duty and a public service, bestowing respect and prestige. Failure to carry out *cargos*, which last one or three years depending on the position, may result in various sanctions (fines, loss of rights, and even banishment in severe cases). Generally, residents are eligible for *cargos* after turning 18, but young people tend to perform *cargos* with less responsibilities, gradually advancing in the *cargo* system to positions of greater authority. Seniors (those aged 60 and over or 65 and over) are often exempted from *cargos*. However, in communities with very few inhabitants (often because of intense out-migration) even seniors are at times asked to carry out some *cargos*.

3) Communal work. This is embodied in the *tequio* and in various forms of mutual help, called *gueza*, *gozona*, or *guelaguetza*, depending on the region. The *tequio* is a form of non-paid collective work that is crucial for the physical maintenance of the community (for example, to build and repair public infrastructure or to carry out reforestations). Like *cargos*, participating in *tequios* is considered a duty and a public service, and failure to participate may result in sanctions. *Gueza*, *gozona*, and *guelaguetza* are forms of non-remunerated mutual help that families grant to other families (for example, to build a house or to sow and harvest a field), which create and reproduce bonds of reciprocity (Fig. 2). Like *cargos*, residents are generally expected to participate in communal work after turning 18 and seniors are often exempted.

Fig. 2. Communal work. *Gueza* to sow a field in the Mixteca Alta UNESCO Global Geopark (municipality of Soyaltepec), March, 2019 (Photo: Quetzalcóatl Orozco-Ramírez).

4) Communal fiestas. Communal celebrations, such as patron-saint festivities and weddings, are a crucial part of a community's culture and identity, representing the glue that holds the community together. These fiestas require ample cooperation, organization, and contributions from the members of the community, reinforcing ties of solidarity and reciprocity, and bringing communal power and communal work together.

These four pillars of *comunalidad* represent a form of social capital that is crucial for the survival and resilience of indigenous communities, allowing these communities to resolve problems that depend on and revolve around collective action (Fuente Carrasco, 2013; Gasca Zamora, 2014; Merino, 2008). Social capital can be understood as a resource for action made available by the relations between actors (Coleman, 1988). Social capital includes phenomena such as strong family and community ties, a well-developed social organization, trust and an easy flow of information among actors, relations of reciprocity, and strong social norms highlighting community engagement (Coleman, 1988; Putnam, 1993). These are precisely some of the features of *comunalidad*.

Comunalidad also closely relates to the concept of "commoning", which refers to a series of collective practices that are prevalent in the successful and sustainable self-governance of commons. Commoning can be described as ways of living in community in which people "collaboratively organise and take responsibility for the use, maintenance and production of diverse resources" (Acksel et al., 2015). It implies joint action, creating things together, and cooperating to meet shared goals (Bollier and Helfrich, 2015, cited in Nightingale, 2019). Crucial to the idea of commoning is that these collective practices are voluntary, self-organized, participatory, inclusive, carried out by people who consider themselves as equal peers, and oriented toward the satisfaction of needs, focused on reproductive and care activities toward oneself, other people, and nature (Acksel et al., 2015; Euler, 2018). However, as noted by Nightingale (2019) and Clement et al. (2019), even commoning has trouble ridding itself of larger power dynamics, as certain exclusions can persist, such as gender inequalities. The same can be said of *comunalidad* and indigenous uses and customs, in which women are often excluded from certain activities and positions of power. Analyzing the various links between *comunalidad* and commoning goes beyond the scope of this paper, but it represents an interesting opportunity for future research.

In this paper, we show that Ostrom's design principles are relevant to explain the successful governance of CPRs in the Mixteca Alta UNESCO Global Geopark. However, we argue that the successful embodiment of Ostrom's design principles in our study area is rooted in *comunalidad*. This in turn demonstrates the importance of taking into consideration the local context and social capital to explain the successful governance of CPRs. Analyzing the link between Ostrom's design principles and *comunalidad* fills a gap in the literature on the governance of CPRs in Latin America. Indeed, to our knowledge, no previous research has thoroughly focused on this link, even though some studies on *comunalidad* do mention Ostrom's work, but only in passing (e.g. Gasca Zamora, 2014; Merino, 2008; Palomino Villavivencio and López Pardo, 2019; Robson et al., 2018; Rodríguez Sperat and Gutiérrez, 2019).

3. Study area

Our study area is comprised of 10 of the 16 agrarian communities of the Mixteca Alta UNESCO Global Geopark.[7] This geopark is located in the northwestern part of the state of Oaxaca, Mexico, and was designated as a UNESCO global geopark in 2017 because of its high geological diversity and the close and ancient relationship between local

[7] The number of agrarian communities in the geopark (16) is higher than the number of municipalities (9) because some municipalities encompass more than one agrarian community.

communities and changes in the landscape (Rosado-González et al., 2020).

The 10 agrarian communities that make up our study area are listed in Table 1 and shown in Fig. 3. Due to time and other constraints, we were not able to study all 16 agrarian communities of the geopark, so we selected 10 that were representative of the different social and environmental conditions of the region. Five agrarian communities (Santiago Tillo, Suchixtlán, Yanhuitlán, Yucucuy, and Yucuita) are located in the valley, a relatively prosperous area where commercial and mechanized agriculture is carried out and where the local economy is relatively diversified. Indeed, these agrarian communities have relatively good quality soils, access to irrigation, and access to local and nearby labor markets, which helps explain a less intense out-migration in these communities in last few decades compared to the other five communities, even though they have all been affected to some degree by emigration and depopulation since the middle of the twentieth century (Lorenzen, 2021, 2022; Lorenzen et al., 2020). The other five agrarian communities (Montelobos, Pozoltepec, Tiltepec, Tonaltepec, and Topiltepec) are located in mountainous areas, which are more marginalized and more affected by out-migration and depopulation, with local economies based mainly on small-scale, rain-fed agriculture. These agrarian communities have relatively small agricultural areas and large wooded areas and grazing lands, and thus a large proportion of common-use lands (Table 1). The main crops, both in the valley and in mountainous areas, are maize, beans, and wheat, while the most common farm animals are sheep, goats, and to a lesser extent bovines (Lorenzen et al., 2020).

These 10 agrarian communities function in a similar way, although their internal rules regarding the use of natural resources vary, as we describe in Section 5. Also, even though the 10 agrarian communities are all relatively small in terms of total area and the number of *comuneros*, there are noticeable differences between them, as shown in Table 1. We should note that the discrepancy in Table 1 between the official number of *comuneros* and the number of *comuneros* actually living in each agrarian community in 2020 is explained by the fact that the official lists of *comuneros* have not been updated since the late 1990s or early 2000s, when a government program (PROCEDE) to measure and certify agrarian communities and *ejidos* was put in place. Since then, many *comuneros* have migrated and some have died without designating a successor.

The fact that in some agrarian communities the official number of *comuneros* (as per PROCEDE) is much higher than the number of *comuneros* actually living in the community (for example, in Tiltepec or Yucucuy) while in other agrarian communities the numbers are closer (especially in Yucuita) does not significantly change local governance or the management of CPRs. What does change is that, in the first group of agrarian communities, the quorum needed to officially start an assembly of *comuneros* (more than 50% of officially listed *comuneros*) is not so easily reached in the first try, and that a second assembly must generally be called, in which, according to Mexican Agrarian Law, the minimum quorum is no longer necessary. It is also important to note that the rights of *comuneros* who have migrated away generally remain intact. What changes is their obligations: since they often cannot carry out *tequios* and *cargos*, they are expected to donate money through hometown associations for various community needs (repairing infrastructure, carrying out reforestations, the patron-saint festivities, etc.).

4. Methods

The results of this paper are based mainly on semi-structured interviews carried out in 2019 and 2020. In 2019, we carried out interviews with 104 informants, including municipal presidents (mayors) and town council members, members of the *comisariados* and oversight councils, and other actors. The interviews were done during the months of March, April, and June of 2019 in 15 towns of the nine municipalities of the Mixteca Alta UNESCO Global Geopark. We also participated in informal conversations, as well as in meetings, assemblies, workshops, and other activities with the geopark's guides, local authorities, farmers, and other local residents. These interviews were carried out to obtain general information about economic activities, migration, and natural resource management in the geopark.

A second round of interviews was carried out between June and July of 2020. Ten local authorities (eight *comisariado* authorities and two municipal authorities) of 10 communities of the geopark (Table 1) were interviewed to better understand local rules relating to CPRs. We employed Ostrom's (1990, 2005) design principles as a framework for these new interviews. These interviews were recorded, transcribed, and reviewed to determine if Ostrom's design principles are relevant to explain a successful governance of CPRs in the 10 agrarian communities. In our analysis, we also included official data about the 10 agrarian communities from Mexico's National Agrarian Registry (RAN, 2020).

5. Results: the role of Ostrom's design principles

The 10 agrarian communities we focus on have succeeded in varying degrees to establish a sustainable governance of wooded areas and grazing lands. All 10 communities have experienced an expansion of woody vegetation (forests and shrublands) in recent decades, with five as early as the 1980s (Montelobos, Suchixtlán, Tiltepec, Topiltepec, and Yanhuitlán), two in the 1990s (Pozoltepec and Yucuita), and three in the late 2000s or early 2010s (Santiago Tillo, Tonaltepec, and Yucucuy) (Table 2). In addition, the 10 agrarian communities have carried out reforestation campaigns and eight have established formal written rules limiting grazing and logging—Montelobos and Yucucuy only have informal rules because they have not yet established their communal statutes. The earliest reforestations took place in the 1980s in Tiltepec and Suchixtlán; followed by Tonaltepec, Yucuita, and Yanhuitlán in the 1990s; Topiltepec and Montelobos in the 2000s; and Pozoltepec, Santiago Tillo, and Yucucuy in the 2010s. These reforestations are generally based on a certain number of saplings donated by Mexico's National Forestry Commission (Comisión Nacional Forestal, CONAFOR). The agrarian communities must apply for these donated

Table 1
Basic characteristics of 10 agrarian communities of the Mixteca Alta UNESCO Global Geopark. Source: RAN (2020), interviews.

Agrarian community	Year of presidential decree	Original number of *comuneros*	Year of PROCEDE certification	Number of *comuneros* as per PROCEDE	*Comuneros* living in the community in 2020	Total area (hectares)	Common-use lands (%)
Montelobos	1943	n/d	Not certified	n/d	40	533.2	n/d
Pozoltepec	1947	130	1998	113	42	1285.8	80.7
Santiago Tillo	1943	n/d	1999	366	100	1024.0	0.0
Suchixtlán	1947	78	1998	168	70	1044.1	22.2
Tiltepec	1945	84	1999	235	40	2112.4	65.8
Tonaltepec	1947	400	2005	117	62	5162.0	92.5
Topiltepec	1961	457	2002	181	90	1170.0	99.8
Yanhuitlán	1944	355	2002	985	400	7007.7	61.1
Yucucuy	1947	269	1998	188	40	897.0	25.9
Yucuita	1943	n/d	2006	134	126	1311.5	14.2

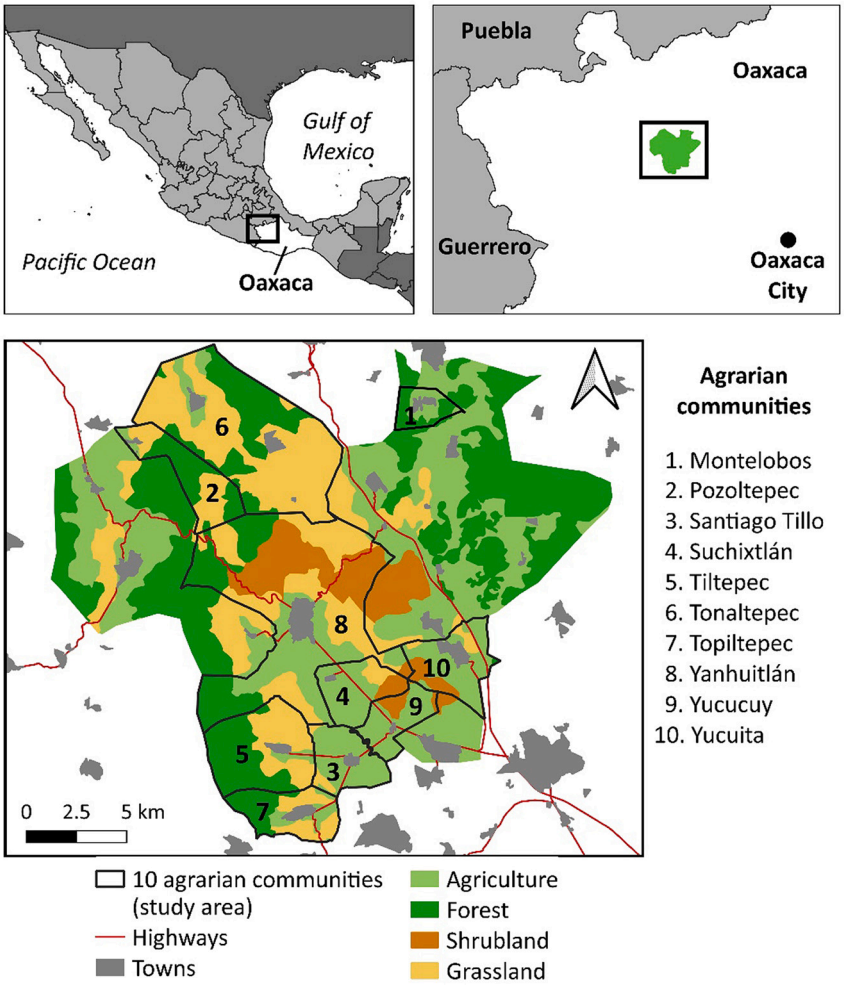

Fig. 3. Land use/cover in the Mixteca Alta UNESCO Global Geopark and location of 10 agrarian communities (study area) within the geopark. Source: INEGI (2017, 2018); RAN (2020).

saplings—CONAFOR periodically announces calls for applications. A basic management plan is associated with these reforestation programs, that may include fencing off the saplings and/or establishing rules to avoid grazing in the reforested areas.

As for the formal grazing and logging rules, the earliest mentioned by the interviewees is a 1980 written assembly decision to ban goats in Suchixtlán; followed by communal statutes approved in Topiltepec, Tonaltepec, Pozoltepec, and Suchixtlán in the 1990s; in Yanhuitlán in 2007; and in Tiltepec, Yucuita, and Santiago Tillo in the 2010s. As mentioned in Section 2, a communal statute is a key document, created following each community's traditions and customs, that establishes the rights and responsibilities of *comuneros* and other residents living in an agrarian community, and which regulates the use of the community's CPRs. In addition, Tiltepec and Yanhuitlán approved territorial zoning plans in 2009 and 2011, respectively.

In the following subsections we analyze the formal and informal rules limiting grazing and logging in the 10 agrarian communities through the lens of Ostrom's design principles.

5.1. Clearly defined boundaries. Authorized users of a CPR should be clearly defined, as should the boundaries of the CPR itself

Ostrom's first design principle can be subdivided in two separate factors that favor a successful governance of CPRs: a) the existence of well-defined boundaries of the resource and b) a clear definition of who may and who may not use the resource.

5.1.1. The existence of well-defined boundaries of the resource

This first factor has two dimensions in our study area. The first is the existence of well-defined boundaries with respect to other agrarian communities and the second is the existence of well-defined boundaries of the CPRs within each agrarian community. As for the first dimension, nearly all interviewees explained that the legal boundaries of their agrarian communities are well defined and that they have no conflicts with neighboring communities concerning these boundaries. The only exception is Montelobos, which has a legal border dispute with the neighboring agrarian community of Coixtlahuaca (see Secretaría de la Reforma Agraria, 1986). The borders of the 10 agrarian communities were established by presidential decree from the 1940s to the 1960s (Table 1). In addition, in the 1990s a government program called PROCEDE to measure and certify agrarian communities and *ejidos* was put in place in Mexico, which provided agrarian communities with further documentation establishing well-defined boundaries. In our study area, the only community that did not participate in the PROCEDE program was Montelobos, because of the ongoing legal dispute with Coixtlahuaca. However, we found no evidence that this border dispute had a negative impact on CPRs.

Despite well-defined legal boundaries, some of the interviewees did mention the problem of people from other agrarian communities trespassing with their farm animals or to extract wood. According to the interviewees, on most occasions, intruders are not aware that they are trespassing, especially in areas where there are no physical markers showing the limits between agrarian communities (such as in wooded

Table 2
Start of woody vegetation expansion, first reforestations, and establishment of rules limiting grazing and logging in 10 agrarian communities of the Mixteca Alta UNESCO Global Geopark. Notes: Six possible years are considered to measure woody vegetation expansion, based on available official land-use/cover maps for 1985, 1993, 2002, 2007, 2011, and 2014. In the case of Santiago Tillo, these maps do not register any woody vegetation as this community is essentially comprised of farmland, although a small reforestation of 15 ha was carried out in 2011, which we consider as the year woody vegetation began to expand. Source: INEGI (1985, 1997, 2003, 2010, 2013, 2017), interviews.

Agrarian community	Start of woody vegetation expansion (period)	First reforestation (year)	Establishment of rules limiting grazing and logging (year, document)
Montelobos	1985–1993	2009	Informal rules
Pozoltepec	1993–2002	2010	1998, Communal statute
Santiago Tillo	2011–2014	2011	2012, Communal statute
Suchixtlán	1985–1993	1989	1980, Written assembly decision to ban goats 1999, Communal statute
Tiltepec	1985–1993	1985	2009, Territorial zoning plan 2010, Communal statute
Tonaltepec	2011–2014	1990	1996, Communal statute
Topiltepec	1985–1993	2005	1995, Communal statute
Yanhuitlán	1985–1993	1996	2007, Communal statute 2011, Territorial zoning plan
Yucucuy	2007–2011	2015	Informal rules
Yucuita	1993–2002	1995	2011, Communal statute

areas). Nevertheless, the problem of trespassing is not widespread, partly because many *comuneros* and other residents can identify the boundaries of their agrarian communities, even in wooded areas; because of the use of sanctions and warnings (see Subsection 5.5); but also because of the factors linked to the forest transition that have meant a decline in the use of CPRs, namely, depopulation, deagrarianization, agricultural intensification, the decline or change in livestock, and the decline in the use of farmland, grazing lands, and local natural resources (Lorenzen et al., 2020, 2021).

Within the agrarian communities, interviewees indicated that *comuneros* and other residents clearly recognize the limits between common-use lands and individual agricultural and residential plots. The PROCEDE program aided in this respect, since individual plots were measured and certified. Tonaltepec is the only exception regarding well-defined internal boundaries. As the secretary of the *comisariado* of Tonaltepec explained:

> The problem here is with a locality that is administratively part of another municipality, but which is within the territory of [the agrarian community of] Tonaltepec, as an annex. […] There are problems with the common-use lands […] because the boundaries are not delimited [between the territories of the two localities]. They don't respect the communal statute, nor do they want to follow our internal rules. […] They practice a lot of free-range grazing, and this is where it is hardest for us to enforce our statute. (T. Bautista, secretary of the *comisariado* of Tonaltepec, July 3, 2020).

As the interviewee noted, the lack of clear boundaries between the territories of two localities in Tonaltepec has repercussions on CPRs and on the enforcement of the communal statute, especially regarding grazing rules, because residents from one of the localities carry out a lot of free-range grazing (essentially of goats and sheep), destroying vegetation in the process.

The cases of Montelobos and Tonaltepec provide interesting information. In the case of Montelobos, the border dispute with a neighboring agrarian community has not had a negative impact on wooded areas and grazing lands, largely because of the small number of users of CPRs, a decline in the number of farm animals, and a decline in the use of natural resources such as wood for fuel and construction. In Tonaltepec, the lack of clear internal boundaries between two localities has had a negative impact on the governance of wooded areas and grazing lands because, according to our interviewees, residents from one of the localities carry out a lot of free-range grazing and do not respect the communal statute.

5.1.2. A clear definition of who may and who may not use the resource

There is a clear definition in the 10 agrarian communities regarding who may and who may not use common-use lands, which encompass communal grazing lands and wooded areas. First of all, people from other agrarian communities are not allowed to use those CPRs. As for people from each agrarian community, and as is to be expected, *comuneros* tend to have more rights to use their community's CPRs than other residents, some of whom are recognized as *avecindados* (see Section 2). However, it is important to point out that *comuneros* also have more responsibilities, including the obligation to serve in positions of authority in the *comisariados* and oversight councils with no pay.

In some cases, the rights of *comuneros* and *avecindados* to use CPRs are very similar, if not identical. In our study area, this is the case of Montelobos, Suchixtlán, Tiltepec, Tonaltepec, Topiltepec, Yucucuy, and Yucuita. On the other hand, in Yanhuitlán, Santiago Tillo, and Pozoltepec the rights of *avecindados* to use CPRs are more restricted. The rights of *comuneros* and *avecindados* to use CPRs are established in the communal statutes, in written assembly decisions, or in longstanding informal rules.

The different rules in each community regarding who may and who may not use CPRs are well understood and respected by *comuneros* and *avecindados*. Indeed, no interviewee described the issue *avecindados* overstepping their rights as a noteworthy problem. In this respect, *avecindados* have a clear interest in not breaking local rules, as this could hinder their access to CPRs and to the possibility of one day becoming *comuneros*.

5.2. Congruence between the rules and local conditions

Rules limiting grazing and logging in the 10 agrarian communities are straightforward. Those rules (both formal and informal) can be divided in three general groups: rules against people from other agrarian communities trespassing with their farm animals or to extract wood, rules limiting grazing by local farm animals, and rules limiting logging by local residents.

As for the rules against people from other agrarian communities trespassing with their farm animals or to extract wood, the general norm in all 10 agrarian communities is that this is not allowed, with the exception of people from other agrarian communities bringing their animals to graze on individual plots (generally farmland) with the written or verbal consent of the owners of those plots.

Concerning the rules limiting grazing by local farm animals, two rules are common to all of the 10 agrarian communities: grazing is not allowed on common-use lands that were recently reforested and people must prevent their farm animals from damaging other people's crops. Other rules are specific to each agrarian community and their severity varies.

The strictest rules are found in Suchixtlán and Tiltepec. In Suchixtlán, goats were prohibited in 1980 by means of a written assembly of *comuneros* decision. According to the president of the *comisariado*, there are no rules in Suchixtlán limiting grazing by sheep and bovines, though he explained that these rules were not necessary, as those animals usually only graze on individual plots and are kept in pens and stables, where they are fed purchased or self-cultivated forages. In Tiltepec, according to the communal statute, people can only have goats and sheep if they are kept in their pens and prevented from grazing on common-use lands and other people's plots. In addition, Tiltepec's communal statute urges residents to keep sheep instead of goats.

In other agrarian communities, grazing on common-use lands is allowed, but only in certain designated areas. According to the

interviewees, this is the case in Montelobos, Pozoltepec, Topiltepec, and Yanhuitlán. In Yucucuy, according to informal rules, grazing by sheep and bovines is allowed on all common-use lands, but goats are prohibited from entering wooded areas. The most lenient grazing rules are found in Santiago Tillo, Tonaltepec, and Yucuita, where grazing by farm animals is allowed on all common-use lands, except in areas with recent reforestations.

It is interesting to note that the geographic location of the communities (in the valley or in mountainous areas) does not seem to play a notable role in the severity of rules limiting grazing. As mentioned above, the strictest rules are found in Suchixtlán, a community in the valley, and in Tiltepec, a mountainous community. Conversely, we noted that the most lenient rules are found in Santiago Tillo and Yucuita, two communities in the valley, and in Tonaltepec, a mountainous community. The difference in the severity of rules limiting grazing is linked to other factors, such as the degree of dependence on livestock raising, as we explain at the end of this subsection.

Regarding the rules limiting logging, half of the 10 agrarian communities outright ban the logging of living trees. This is the case of Santiago Tillo, Suchixtlán, Tiltepec, Yanhuitlán, and Yucuita. In these cases, only dead trees may be logged, and generally only for domestic use (that is, not for sale). In addition, logging dead trees requires the permission of the respective *comisariados*. In the other five communities (Montelobos, Pozoltepec, Tonaltepec, Topiltepec, and Yucucuy), cutting down living trees is allowed, but only for domestic use and with the permission of the respective *comisariados*.

As opposed to rules limiting grazing, in the case of rules limiting logging there does seem to be a difference between valley communities and mountainous communities. Indeed, as noted above, four of the former have stricter logging rules (Santiago Tillo, Suchixtlán, Yanhuitlán, and Yucuita), while four of the latter have somewhat more lenient logging rules (Montelobos, Pozoltepec, Tonaltepec, and Topiltepec). The outliers are Tiltepec and Yucucuy. The main reason for this difference between valley communities and mountainous communities is straightforward: valley communities tend to have smaller forested areas and thus a more evident need to protect those areas.

According to our interviewees, prior to the 1980s the regulation of grazing and logging was virtually inexistent or ineffective in the 10 agrarian communities. The governance of CPRs started to change in the 1980s and especially from the 1990s onward, partly because of demographic and socioeconomic changes. Indeed, as we show elsewhere (Lorenzen et al., 2020, 2021), the establishment of rules limiting grazing and logging in the geopark was facilitated by the forest transition and its causes. Thus, interviewees explained that the establishment of those rules would have been harder in the past, when the agrarian communities had larger populations, more people working in agriculture, more livestock, and depended more on local natural resources, such as wood for fuel and construction. In addition, since fewer families now base their wealth on large herds and extensive livestock raising, depending instead on intensive and mechanized agriculture and/or non-agricultural activities, it became easier for the agrarian communities to establish rules limiting grazing, as well as to carry out reforestation campaigns on former grazing lands. These factors help explain why there is a congruence between the rules and local conditions.

Interviewees were asked specifically if the grazing and logging rules were well adapted to the local population and the local conditions. The answer was a unanimous yes. For example, the president of the *comisariado* of Topiltepec said simply: “Yes, these are rules that, we could say, fit in with people's way of life.” (E. González, president of the *comisariado* of Topiltepec, June 23, 2020). The president of the *comisariado* of Suchixtlán also noted that:

> Yes [the rules are well adapted] because forests have grown and now there isn't so much demand for firewood. With the introduction of gas, firewood isn't used so much anymore. As for goats, they have almost completely disappeared, which is why we have no trouble enforcing the rules. (N. Hernández, president of the *comisariado* of Suchixtlán, June 27, 2020).

The rules limiting grazing and logging are thus well-suited to a changing rurality, characterized by a decline in the number of users of CPRs and in the overall use of those resources. However, as we explain in the following subsection, establishing rules limiting grazing and logging in our study area was not generally easy. It involved lengthy negotiations in the assemblies of *comuneros*, especially between those who still had many farm animals and other residents who wished to protect CPRs.

The existence of lenient grazing rules in Santiago Tillo, Tonaltepec, and Yucuita can also be interpreted as a congruent fit with local needs and conditions. Interviewees from Santiago Tillo and Yucuita noted that these lenient rules were linked to the fact that few people had farm animals and that the number of animals was small and had decreased in the last three decades. Indeed, while explaining why these rules were lenient, the municipal president of Yucuita explained that it was “not because we are irresponsible, but because there aren't so many farm animals anymore” (R. Hernández, municipal president of Yucuita, June 22, 2020). The case of Tonaltepec is different, since the lenient rules in this community are explained by the fact that farm animals are still central to local livelihoods—indeed, more than 64% of the economically active population in the municipality of Tonaltepec worked in the primary sector in 2020, compared to 42.4% overall in the nine municipalities of the geopark (INEGI, 2020).

5.3. *Collective-choice arrangements. Most or all of the users of a CPR should be able to participate in modifying the rules*

The rules limiting grazing and logging in the 10 agrarian communities were not imposed by small groups of decision makers, but rather were collective decisions involving the assemblies of *comuneros*, which represent the highest authority in agrarian communities. The proportion of *comuneros* residing in their agrarian communities who participate in the assemblies is generally high. According to the interviewees, this proportion is nearly 100% in Montelobos, Pozoltepec, Santiago Tillo, Suchixtlán, Tiltepec, and Yucucuy. In Topiltepec it is around 80%, in Tonaltepec around 70%, in Yanhuitlán about 50%, and in Yucuita above 40%. As is to be expected, these percentages tend to be higher when the assemblies deal with critical issues, such as approving or changing the communal statutes.

In addition, the decisions to establish rules limiting grazing and logging were not generally taken from one day to the next. Various workshops and assemblies were often organized in each agrarian community to discuss the possibility of establishing the new rules, to weigh the pros and cons, to make sure that everyone understood the new rules and the sanctions, and to ensure a sufficient consensus. This form of collective decision-making process based on prior workshops and the assembly of *comuneros* is key to ensure the legitimacy of the rules, as well as a high compliance. As the secretary of the *comisariado* of Tiltepec noted:

> Yes, the rules are obeyed. People have to accept them, they have to obey, because workshops were carried out to discuss the rules, and all of the *comuneros* were invited to participate in the workshops. Two or three workshops were carried out and all of the *comuneros*, or most of them, participated in those workshops. […] Most of the *comuneros* were in the assemblies where the rules were accepted and they were in the workshops. Everything was made very clear. […] All of the rules are written in the statute. These are the rules of our people, their rights and responsibilities. (F. Pérez, secretary of the *comisariado* of Tiltepec, June 23, 2020).

This does not mean that there was no opposition to establishing rules against grazing and logging in the 10 agrarian communities. Several interviewees described that when these new rules were being discussed, some *comuneros*, especially those with many farm animals, did oppose

the changes and did not comply immediately with the new rules. However, the use of sanctions, general collective pressure, and the legitimacy of the rules linked to their approval by the highest communal authority—the assembly—soon led to a high compliance. As is the case in the establishment of those rules, modifying them can only be done by the assembly of *comuneros*, though very few changes have been made to the communal statutes of the 10 agrarian communities.

Lastly, even though *avecindados* do not have the right to vote in the assemblies of *comuneros*, they are not completely excluded from the decision-making process. Indeed, in some agrarian communities they are allowed to participate in these assemblies and voice their opinion. However, the number and proportion of *avecindados* in the 10 agrarian communities varies greatly. For instance, according to our interviewees, in Tiltepec there are 62 *avecindados* and 40 *comuneros* living in the community, while in Yanhuitlán there are only 20 *avecindados* and 400 *comuneros* living in the community.

5.4. Monitoring. Rules should be enforced by effective monitoring activities. The monitors should be accountable to the users of the CPR or they should be the users themselves

In the 10 agrarian communities, the CPRs and compliance with the rules limiting grazing and logging are monitored by the *comisariados*, with the assistance of the oversight councils (*consejos de vigilancia*), and often with the help of municipal authorities, except in Santiago Tillo, Topiltepec, and Yucucuy, where municipal authorities do not assist in these monitoring activities. In addition, in all of the 10 agrarian communities the *comuneros* themselves—not only those in positions of authority—and other residents help monitor the CPRs and people's compliance with the rules. This participatory surveillance greatly eases monitoring activities, which would be difficult to carry out if only the members of the *comisariados* were involved.

In the larger agrarian communities, such as Yanhuitlán, the help of municipal authorities is key, since the members of the *comisariados* find it hard to monitor large areas by themselves. As the president of the *comisariado* of Yanhuitlán explained, the authorities of the municipal agencies—that is, localities other than the municipal capital (*cabecera municipal*)—play a crucial role in monitoring the CPRs and the compliance with the rules:

> Surveillance is carried out by the *comisariado*, the *comuneros* themselves, and the municipal agents of each locality. We have eight agencies, each with its own agent, its representative. They help us identify problems. […] They carry out surveillance in the part of the territory that corresponds to them. […] Any anomaly that they see, they immediately let the *comisariado* know. Then we go take a look and inspect the damage or any anomaly. If a perpetrator has been identified, we summon him to the office and talk to him. (E. Jiménez, president of the *comisariado* of Yanhuitlán, June 24, 2020).

Accountability of the members of each *comisariado*, who are the main actors responsible for monitoring the CPRs and the compliance with the rules, is ensured first of all by the oversight council (*consejo de vigilancia*), which is tasked with monitoring the *comisariado*'s use of funds and its compliance with agrarian law and local rules (Cámara de Diputados, 2018). Any irregularities found by the oversight council are reported to the assembly of *comuneros*. Secondly, accountability is ensured by the assembly of *comuneros* itself.

5.5. Graduated sanctions. Users of a CPR who violate rules should be assessed graduated sanctions depending on the seriousness and the context of the offense

Graduated sanctions refer to the fact that the severity of each sanction depends on either the severity or the repetition of the violation. This would help ensure a better compliance with the rules, as people are given the opportunity to change their behavior before being imposed large sanctions, thus perceiving the rules as fair and legitimate.

Graduated sanctions are a widespread practice in the 10 agrarian communities. First of all, sanctions against people from other agrarian communities trespassing with their farm animals or to extract wood are graduated. However, we found that the imposition of fines against trespassers is very rare in the 10 agrarian communities. This is partly because the boundaries between agrarian communities are well-defined (see Subsection 5.1), but also because *comisariados* issue verbal and written warnings before imposing fines.

For example, in the case of Yucucuy, the president of the *comisariado* explained that he first verbally warned those he found trespassing with their farm animals or extracting wood, telling them that he would confiscate some of their animals and/or impose a fine is he found them a second time. After, he sent written letters to the *comisariados* of neighboring agrarian communities to explain the sanctions he would impose if he found people from those communities trespassing with their animals or to extract wood. Those early warnings were effective, as he noted that he had not had the need to confiscate animals or impose fines on trespassers since he became president of the *comisariado* of Yucucuy in early 2019.

We also observed that graduated sanctions are used to enforce rules limiting grazing by local farm animals, rules limiting logging by local residents, and rules to protect recent reforestations. The general sequence of enforcement involves giving verbal or written warnings to first offenders and then imposing sanctions (usually fines, but also community work) to repeat offenders. Those sanctions are graduated and depend on the severity of the violation.

For instance, in the case of Tonaltepec, people who cut down trees without the permission of the *comisariado* must plant a certain number of trees for each tree that was logged. However, the number of trees that must be planted for each tree cut down is not fixed, as it depends on the number, the size, and the species of trees that were logged. Repeat offenders are also treated more harshly. In addition, each case is treated differently according to the socioeconomic conditions of the offenders. In the words of the secretary of the *comisariado* of Tonaltepec:

> In very drastic cases in which the offender does not comply, the sanction may go from 10 [trees planted] for one [tree cut down], to 20 for one, and we even had a case that was 30 for one. So, if he cut down 10 trees, he would have to plant 300. The sanctions aren't fixed. […] The sanctions also depend on the socioeconomic condition of each *comunero* or citizen. It varies a lot. (T. Bautista, secretary of the *comisariado* of Tonaltepec, July 3, 2020).

The secretary of the *comisariado* of Tonaltepec went on to explain that people who let their farm animals graze in areas that were recently reforested are also imposed graduated sanctions. First, they are given verbal warnings and then, if they repeat the offense, they are imposed sanctions that may be monetary or, if they cannot afford to pay a fine, in the form community work. The magnitude of the fines and the number of days of community work depend on the severity of the violation. Providing warnings has been a way to "steer our people so they can avoid those negative points, the sanctions", the secretary of the *comisariado* said.

5.6. Conflict-resolution mechanisms. Users of a CPR and their officials should have rapid and easy access to low-cost local arenas to resolve conflicts

Most conflicts in agrarian communities in Mexico are resolved in their respective assemblies of *comuneros*, which represent the highest internal authority. This arena to resolve conflicts is cost free to those involved and is relatively swift. According to Mexico's Agrarian Law, agrarian communities must carry out a minimum of one assembly of *comuneros* every six months (Cámara de Diputados, 2018). In addition to these ordinary assemblies, agrarian communities tend to carry out extraordinary assemblies as need be. Only in exceptional cases are

conflicts in agrarian communities in Mexico taken to federal agrarian tribunals.

5.7. Minimal recognition of rights to organize. The rights of users of a CPR to devise their own institutions should not be challenged by external governmental authorities

As we mentioned before, agrarian communities in Mexico were established by presidential decree during and after the 1910–1920 Revolution, while in the 1990s a government program called PROCEDE was put in place to measure and certify agrarian communities and *ejidos*, which provided them with further documentation establishing well-defined boundaries, both regarding their external boundaries and their internal boundaries delimiting residential plots, agricultural plots, and common-use lands (mainly wooded areas and grazing lands). Thus, from their beginning, agrarian communities in Mexico have had official government recognition and were formalized by the Mexican State. This recognition and formalization go beyond a mere acknowledgement of their boundaries.

Indeed, the rights of agrarian communities and *comuneros* is established in Mexico's Agrarian Law (Cámara de Diputados, 2018). This law recognizes that agrarian communities are legal entities with their own assets and that they are the possessors of the lands they were granted by presidential decree or that they acquired by other means. As noted in Section 2, the law acknowledges that the assembly of *comuneros* is the highest authority in an agrarian community, that it elects and can remove the members of the *comisariado* (which represents the agrarian community and carries out the decisions of the assembly), that the *comisariado* is in turn monitored by an oversight council, and that agrarian communities operate based on their own internal rules, as long as those rules do not contradict the law. It states that those rules (the communal statutes) are to be registered in Mexico's National Agrarian Registry (RAN) and should include general principles guiding the social and economic organization of the agrarian community, requirements to accept new *comuneros*, rules governing common-use lands, and other issues relevant to each agrarian community. Thus, Mexico's Agrarian Law specifically states that agrarian communities may put in place internal rules to regulate the use, exploitation, access to, and conservation of common-use lands, as well as to establish the rights and responsibilities of *comuneros* and *avecindados* with respect to those lands. In sum, the rights of *comuneros* to devise their own rules regarding their CPRs is established clearly in Mexican law.

In addition, we found in our study area that external government institutions have aided agrarian communities to devise their local rules. According to the interviewees, this is the case of Suchixtlán, Tiltepec, and Tonaltepec. In the case of Tiltepec, Mexico's National Forestry Commission (CONAFOR) provided a consultant to help the community draft its communal statute and its territorial zoning plan. In the cases of Suchixtlán and Tonaltepec, help was provided by the Agrarian Bureau (Procuraduría Agraria) to help design their communal statutes. It is also important to note that reforestation efforts in all of the 10 communities, except Suchixtlán, have received support from CONAFOR. This support is generally in the form of donated tree saplings. In addition, Yanhuitlán has received payments for ecosystem services (PES) through CONAFOR, which it uses to help manage its forests (for example, some of the funds were used in 2022 to help restore an area affected by a forest fire).

6. Discussion: the links between Ostrom's design principles and *comunalidad*

It is not hard to see how Ostrom's design principles are connected to the ethos of *comunalidad* in our study area. What is more, the successful embodiment of Ostrom's design principles in our study area is rooted in the contextual factor of *comunalidad* and its four constituent elements—a communal territory, communal power, communal work, and communal fiestas (see Table 3 for a summary of the links between Ostrom's design principles and the elements of *comunalidad*). This ethos of *comunalidad* encompasses collective practices that seek to guarantee and reproduce life in rural and indigenous communities, practices that are in turn rooted in pre-Hispanic production systems and worldviews (Leff, 2002).

Table 3
Summary of the links between Ostrom's design principles and the constituent elements of *comunalidad* in the Mixteca Alta UNESCO Global Geopark.

Ostrom's design principles	Constituent elements of *comunalidad*
1. a) Clearly defined boundaries of CPRs	• Communal territory as the basis of the existence of an agrarian community • Communal work and communal power, through the *comisariados*, used to verify border markers between agrarian communities.
1. b) Clear definition of who can use the CPRs	• Communal power, through the assembly, as the basis of the recognition of *comuneros* and of the definition of the rights and responsibilities of *comuneros* and *avecindados*
2. Congruence between the rules and local conditions	• Ensured through the participation of the users of the CPRs in the assemblies of *comuneros* (communal power) to define the rules. • Provision activities based on communal power (through the *comisariados*) and communal work (through *tequios*).
3. Collective-choice arrangements	• Most of the users of the CPRs participate in establishing the rules by attending the assemblies of *comuneros* (communal power). Only *comuneros* may vote, but *avecindados* can often participate and voice their opinion.
4. Monitoring	• Idea of communal territory instills the importance of defending and monitoring the CPRs. • Monitoring based on communal power (through the *comisariados* and oversight councils). • Accountability of the monitors through the power of the assembly of *comuneros* (communal power). • Monitoring also based on communal work. • Participatory surveillance nurtured by communal work and communal fiestas.
5. Graduated sanctions	• Graduated sanctions established by the assemblies of *comuneros* and the *comisariados* (communal power).
6. Conflict-resolution mechanisms	• Conflicts within the agrarian communities are generally resolved in their respective assemblies of *comuneros*. • Communal work and communal fiestas help prevent conflicts within the agrarian communities and represent other arenas for conflict resolution.
7. Minimal recognition of rights to organize	• Communal power as the basis for the recognition of agrarian communities and their relative autonomy regarding the governance of their CPRs, seeking to ensure a control over their territories.

By highlighting the importance of a communal territory as the basis of the existence of a community, both in material and symbolic terms, *comunalidad* reinforces the first design principle of clearly defined boundaries of a CPR. By "knowing the land" through their daily activities, *comuneros* are generally able to identify the boundaries of their agrarian communities, as well as the boundaries of the CPRs within their communities. In addition, many of the boundaries between agrarian communities are marked with boundary stones (*mojoneras*), through which the border lines run. A regular activity of the members of the *comisariados*, often done with the help of other *comuneros*, is to make sure these *mojoneras* are visible and still intact, carrying out rounds along the border of their communities to identify the boundary stones and other boundary markers. In other words, the clearly defined borders between agrarian communities are also ensured by means of communal work and communal power, two other elements of *comunalidad*. Communal power is also key to define who is able or not to use the CPRs

within the communities (the second aspect of Ostrom's first design principle). Indeed, the establishment of the rights and responsibilities of *comuneros* and other residents, including regarding the use of the communities' CPRs, is based on the main institution of communal power in the agrarian community—the assembly of *comuneros*.

However, as noted in Section 2, it is important to recognize that there are power inequalities within agrarian communities that are linked to who is and who is not a *comunero*. These power inequalities manifest themselves especially in terms of gender and age, since most *comuneros* are older men. Nevertheless, as we also explained above, these power inequalities are not absolute, as *avecindados* often have the right to use the CPRs in their agrarian communities and often may voice their opinion in the assemblies of *comuneros*, even though they cannot vote.

The materialization of Ostrom's second, third, fifth, and sixth design principles in our study area is also based on communal power, whereby major decisions are reached by the assembly, preferably through a consensus or near consensus. Thus, by attending the assemblies, most of the users of the CPRs (*comuneros* and to a certain extent *avecindados*) participate in establishing the rules regulating the use of those resources (third design principle), which ensures that these rules are congruent with local conditions (second design principle). As we noted in the previous section, approving those rules is not done from one day to the next, but generally involves long discussions and workshops in various assemblies. Those rules include not only appropriation rules (rules limiting appropriation of the resource by the users), but also provision rules, that is, rules requiring users to actively help enhance and maintain CPRs through their labor and resources. Activities to enhance and maintain CPRs in our study area are ensured by communal power and communal work, or, more precisely, by members of the communities elected to carry out positions (*cargos*) in the *comisariados* and by members of the communities who participate in *tequios* (non-paid collective work), such as reforestations and wildfire suppression.

In addition, the assemblies and the *comisariados* establish the sanctions against rule-breakers, some of which were put into writing in the communal statutes, and those sanctions are generally graduated (fifth design principle) to ensure a better compliance. The establishment of graduated sanctions is also bound to *comunalidad* because of the weight of seeking a consensus or near consensus in the assembly. Thus, efforts are made to avoid harsh sanctions that may upset the social fabric, except when they are truly needed to reinforce social norms. What is more, sanctions are often discussed on a case-by-case basis in assemblies to make sure that they correspond to the seriousness and the context of the offense, and are adapted to the socioeconomic conditions of each offender. However, we found that the issuance of sanctions is rare in our study area because rule breakers are normally first given verbal or written warnings and because of the legitimacy of the rules linked to their approval by the assembly of *comuneros*, the highest internal authority in each agrarian community. For their part, conflicts within the agrarian communities are generally resolved in their respective assemblies of *comuneros*, which represent cost-free and relatively swift conflict-resolution mechanisms (sixth design principle). Lastly, by reinforcing ties of solidarity and reciprocity, communal fiestas and communal work help prevent conflicts within the communities and represent other possible informal arenas for conflict-resolution.

The fourth design principle—monitoring activities and accountability of the monitors—is connected to all four elements of *comunalidad*: a communal territory, communal power, communal work, and communal fiestas. Thus, monitoring is the direct responsibility of members of the community elected to carry out positions (*cargos*) in the *comisariados* and oversight councils, who make a great effort to carry out their responsibilities successfully since, as mentioned in Section 2, *cargos* are considered a duty and a public service, bestowing respect and prestige. In addition, the power of the assembly helps ensure the accountability of those carrying out *cargos*. On the other hand, *comunalidad* instills the importance of defending and watching over the communal territory and its resources, not only by those directly responsible (the members of the *comisariados*), but by all of the members of the community, as a form of communal monitoring. Strong social ties, mutual trust, and an easy flow of information among members of the community, nurtured by communal work and communal fiestas, also facilitates this participatory surveillance.

The seventh design principle—a minimal recognition of rights to organize—is also tied to *comunalidad*, which, as mentioned before, forms the basis of indigenous resistance in Mesoamerica starting from the colonial period to current struggles for autonomy and self-determination. Thus, indigenous movements in the 1980s and 1990s pushed for a formal recognition of *usos y costumbres* in Oaxaca, giving indigenous communities greater autonomy in the way they govern themselves. The creation of agrarian communities and *ejidos* in the 20th century, as well as their relative autonomy regarding the governance of their CPRs, was itself a result of peasant and indigenous struggles during and after the Mexican Revolution, seeking to ensure control over their territories, as mentioned in Section 2. This formalized indigenous commons in Mexico, both regarding boundaries and local governance structures.

7. Conclusions

In this paper, we confirmed the relevance of Ostrom's design principles to explain the successful governance of wooded areas and grazing lands in our study area in Mexico's Mixteca Alta region. We also noted that a more complete explanation of this successful governance of CPRs must take into consideration the characteristics of local governance systems in rural Oaxaca, which are based on indigenous uses and customs and an ethos of communality (*comunalidad*). However, it is important to recognize that one of the reasons for the success of this local management has been support from the Mexican State, which formalized agrarian communities (both their boundaries and governance structures) and has provided other assistance (for instance, help to draft some of the communal statutes and aid to carry out and manage reforestations). Nevertheless, it is crucial to highlight the local context of communality, since the governance of common-pool resources is far from successful in *ejidos* and agrarian communities in other parts of Mexico and even of Oaxaca.

This ethos of *comunalidad* has functioned as a form of social capital in our study area, bolstering Ostrom's design principles and helping the 10 agrarian communities successfully govern their CPRs. What is more, the governance of wooded areas and grazing lands in the 10 agrarian communities is largely based on the social organization, the community ties, the trust and easy flow of information among actors, the relations of reciprocity, and the strong social norms highlighting community engagement that are characteristic of *comunalidad*. Thus, the successful embodiment of Ostrom's design principles in our study area is rooted in *comunalidad*, which demonstrates the importance of taking into consideration the local context and social capital to explain the successful governance of CPRs.

However, this local context goes beyond *comunalidad*. Indeed, it is also important to recall that the successful embodiment of Ostrom's design principles in our study area and the effective governance of CPRs did not occur until the 1980s and 1990s, when the political, demographic, socioeconomic, and environmental conditions were ripe, providing a window of opportunity spurring changes in the governance of CPRs (Lorenzen et al., 2021). Indeed, as noted in Section 5, prior to the 1980s the regulation of grazing and logging was virtually inexistent or ineffective but started to change from the 1990s onward, as pressure on local resources declined because of out-migration, the decline of farming and livestock raising, and the decline in the use of wood for fuel and construction, but also as new institutions such as CONAFOR were created (Lorenzen et al., 2020, 2021).

Even though this paper provides preliminary evidence showing the importance of *comunalidad* in explaining the successful and sustainable governance of CPRs, in large part by buttressing Ostrom's design

principles, much additional work is needed to corroborate this thesis. A promising approach for future research is comparing the governance of CPRs in regions that have similar demographic, economic, and biophysical characteristics, but that are dissimilar with respect to the existence of an ethos of *comunalidad*. This could be done by comparing the governance of CPRs in *ejidos* and agrarian communities in areas of southern Mexico, where the ethos of *comunalidad* is pervasive, and in areas of northern Mexico, where it is not. Such research may provide key information on the links between the local context, social capital, and the successful governance of CPRs.

Lastly, two main policy recommendations can be discerned from this case study. The first is that the successful self-management of CPRs is greatly facilitated when the State formalizes the boundaries and forms of governance of local communities, and otherwise backs local communities' efforts to manage their natural resources. In other words, it is crucial for governments to not only pay lip service to community management, but also to back it up with modern day legislation and policies, without which such management is more likely to fail. Secondly, it is crucial to take into consideration local community rules regarding CPRs before implementing any policy regarding these resources, and those policies must be adapted to local forms of governance. For instance, CONAFOR reforestations and programs could be improved by recognizing *tequios* as viable mechanisms for forest management; also, recognizing the effectiveness of formal and informal grazing rules could reduce the need to invest in fences to protect new reforestations, which would free up those resources to be used for other necessities.

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Matthew Lorenzen: Conceptualization, Methodology, Investigation, Data curation, Formal analysis, Writing - original draft, Writing - review & editing. **Quetzalcóatl Orozco-Ramírez:** Conceptualization, Methodology, Investigation, Data curation, Formal analysis, Writing - original draft, Writing - review & editing. **Rosario Ramírez-Santiago:** Conceptualization, Methodology, Investigation, Data curation, Formal analysis, Writing - original draft, Writing - review & editing. **Gustavo G. Garza:** Conceptualization, Writing - original draft, Writing - review & editing.

Declaration of Competing Interest

We have no conflicts of interest to disclose.

Data availability

Data will be made available on request.

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